

DIRECTIONAL INPUT SYSTEM WITH AUTOMATIC CORRECTION

The present application is a continuation-in-part application to the copending application, U.S. Serial No. 09/580,319, filed on May 26, 2000, entitled "KEYBOARD
5 SYSTEM WITH AUTOMATIC CORRECTION", and continuing application, U.S. Serial No. 10/205,950, filed July 25, 2002 entitled "CHINESE CHARACTER HANDWRITING RECOGNITION SYSTEM".

BACKGROUND OF THE INVENTION

TECHNICAL FIELD

10 This invention relates generally to input devices. More particularly, the invention relates to a directional input system with automatic correction.

DESCRIPTION OF RELATED ARTS

To operate a computing device, such as a computer, one or more input devices must be connected thereto. Since the early days of the computing age, the keyboard has
15 been the primary input device for users to input textual messages into to computing devices. The textual messages may be commands for the computers to execute, or just plain data entry if he's using a keyboard as an input device. However, the user must memorize the correct spelling and syntax of computer commands. Even if the user has memorized the correct spelling, the input of data with keyboard itself can be
20 error prone. Hence, a graphical user interface (GUI) has been developed for

computing devices to reduce the use of keyboard. In a GUI, the user operates an alternative input device, such as a mouse, trackball, or joystick, to move around a cursor or pointer on the display. Once the cursor is moved to the desired position, a button is pressed and released, and a corresponding computer command is thus executed. Although a GUI provides an alternative way to invoke computer commands, the keyboard continues to serve as the primary text entry input device for computing devices.

Nevertheless, there are situations such as in console video-game machines or hand held devices with a joystick or joystub, where a traditional keyboard is neither available nor convenient. Currently, the text entry method for these systems usually consists of scrolling through an alphabet or on-screen QWERTY keyboard. Another commonly adopted navigation means in video-game machines provides users with a pie menu, which is a circular menu that allows users choose items by dragging the pointing device in the direction of the menu item. To input a word, the user must select each letter by scrolling through an alphabet list, navigating through the pie menu, or locating it on the on-screen keyboard and click a selection button after each letter is located.

The above text entry method has numerous disadvantages. For example: the method is inefficient because the user has to spend time in locating the letter and confirming the letter; the method is inconvenient because it breaks the normal typing flow when inserting clicks between letter selections; and the method is ineffective because the user could easily mistake an adjacent letter for the limited size of the on-screen keyboard.

What is desired is an effective text entry input system using a directional input means such as a joystick or trackball device. It is further desired that the text entry input system is intuitive and easy to operate. It is still further desired that the text entry input system can provide auto-correction of input mistakes.

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SUMMARY OF THE INVENTION

The invention provides a directional input system associated with a text entry application, such as email or instant messaging. The system comprises an optional onscreen representation of a circular keyboard, a list of potential linguistic object matches, and a message area where the selected words are entered. The circular
10 keyboard is manipulated via a hardware joystick or game-pad having an analog joystick or omni-directional rocker switch built therein. The user points the joystick in the general direction of the desired letter, and then continues pointing roughly to each letter in the desired word. Once all letters have been roughly selected, buttons or equivalent means are used to select a specific word from the list of potential
15 matches and to send the selected word to the message area.

In one preferred embodiment, the invention provides a text entry input system which includes: (1) a directional selection means, plus one or more buttons or equivalent user input means; (2) a list of linguistic objects, organized by frequency of use; (3) an output device with a text display area; and (4) a processor which includes an object
20 search engine, a distance or angular value calculation module, word module for evaluating and ordering words, and a selection component.

The directional selection means is used to point in the direction of each letter of a word. The processor calculates a distance or an angle to find letters and weight values for the letters in the pointing direction with the distance or the angle calculation module, retrieves a predicted list of words based on the letters and weight values with the object search engine, and evaluates and orders the predicted list of words with the word module. The selection component is used to select a desired word from the predicted list of words.

In another preferred embodiment, the invention provides a text entry input method using a directional selection means. The method includes the steps of:

- 10 • The user moving a cursor on an on-screen keyboard in the direction of a desired letter using the directional input means;
- Recording the X-Y coordinate position of the cursor;
- Converting the recorded X-Y coordinate position into the corresponding set of polar coordinates;
- 15 • Applying a selection weight value to each input based on the set of polar coordinates of the recorded cursor position; and
- Retrieving a list of predicted words from a vocabulary database based on the weight value for each input and a plurality of pre-determined values.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a directional input system according to the invention;

FIG. 2 is a schematic diagram depicting an exemplary screen of the display device
5 corresponding to the directional input system of FIG. 1;

FIG. 3 is a schematic diagram depicting a preferred layout of an on-screen keyboard according to the invention;

FIG. 4A is a schematic view of a set of compass points according to one embodiment of the invention;

10 FIG. 4B is a schematic view of a set of compass points around the word selection list according to another embodiment of the invention;

FIG. 5 is a schematic view of an on-screen feedback of the directional input system according to the invention;

FIG. 6 is a flow diagram illustrating a process for precision input mode of the
15 directional input system according to the invention; and

FIG. 7 is a flow diagram illustrating a process for operating the directional input system according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

The invention provides a directional input system associated with a text entry application, such as email or instant messaging. The system includes an optional onscreen representation of a circular keyboard, a list of potential linguistic object
5 matches, and a message area where the selected words are entered. The circular keyboard is manipulated via a hardware joystick or game-pad having an analog joystick or omni-directional rocker switch built therein. The user points the joystick in the general direction of the desired letter, and then continues pointing roughly to each letter in the desired word. Once all letters have been roughly selected, buttons
10 or equivalent means are used to select a specific word from the list of potential matches and send the selected word to the message area.

System Construction and Basic Operation

FIG. 1 is a block schematic diagram illustrating a directional input system 100 incorporated in a home video game console machine according to the preferred
15 embodiment of this invention. The input system 100 includes an analog joystick 110 having one or more buttons, a vocabulary module 150 which stores a collection of linguistic objects, a display device 120 having a text display area, and a processor 140. The processor 140, which connects the other components together, further includes an object search engine 142, a distance calculation module 144 for
20 calculating distance value, a word (linguistic object) module 146 for evaluating and ordering words, and a selection component 148. The system 100 may further include an optional on-screen representation of a keyboard 130 showing on the display device 120.

The joystick 110 serves as a directional selection input device, which provides a possibility of directional input with a sufficient precision, preferably 10° or more precise. It is preferable that the default position of the cursor, if it is shown, is at the center of the circle of letters. It is possible to use a joystick device to navigate in two dimensions an on-screen “QWERTY” or “ABC” keyboard, either in the standard rectangular form or in a circular layout. It is also possible to navigate through multiple concentric rings of characters. It is the goal of this invention, however, to depend only on the joystick in its center/resting position and its non-centered (or perimeter) positions, *i.e.* using the radial direction rather than the specific degree of tilt.

10 As soon as a direction has been established by some degree of tilt from the center, the input may be registered and recorded. It may still be beneficial to the user, however, to allow the direction to be altered slightly before recording it. Therefore, the last effective direction is only recorded after the joystick is returned to its resting position in the preferred embodiment of the invention.

15 Although analog joystick is described as the preferred directional selection device, any input device that provides the possibility of directional input with a sufficient precision can be used. For examples: omni-directional rocker switch, thumbstick, *e.g.* IBM TrackPoint™, touchpad, touchscreen, touchscreen and stylus combination, trackball, eye tracking device, trapped-disk sliding switch, steering wheel, Apple
20 iPod™ Navigation Wheel, or Sony’s Jog-dial and data glove, *e.g.* old Nintendo Game Glove, can be used as alternative.

The joystick input device preferably has eight buttons. However, it may only have one button, or any other number of buttons. Note that the stick itself does not usually

have that many buttons despite the fact that the joystick base or enclosing game controller may have. A 4-way directional hat switch or jog-dial may be used to support multiple functions, both for character input and for secondary navigation. In addition, a joystick may be pressed straight down (z-axis) to provide an additional
5 button.

These buttons provide a mechanism for explicit commands to the system. One of the buttons may invoke a menu which contains additional commands. Another button may change the set of characters which may be selected via the directional input.

In an alternate embodiment, a second joystick or omni directional rocker switch is
10 used to invoke some of the explicit commands of the system. For example, tilting the joystick up and down scrolls through the word choices and tilting it to the right extends the current word with a choice of suffixes.

The linguistic objects that are stored in the vocabulary module 150 include but not limit to: words, phrases, abbreviations, chat slang, emoticons, user IDs, URLs, non-
15 English (such as Chinese or Japanese) characters. Although words are used in the preferred embodiments, any other linguistic objects are equally applicable. Similarly, although the term "letter" or "character" is used in the preferred embodiment, other sub-word components from Non-English languages, *e.g.* strokes, radicals/components, jamos, kana, plus punctuation symbols and digits, are equally
20 applicable.

The list of predicted words is ordered in accordance with a linguistic model, which may include one or more of: frequency of occurrence of a word in formal or conversational written text; frequency of occurrence of a word when following a

preceding word or words; proper or common grammar of the surrounding sentence; application context of current word entry; and recency of use or repeated use of the word by the user or within an application program.

FIG. 2 is a schematic diagram depicting an exemplary screen of the display device 120 corresponding to the directional input system 100 of FIG. 1. The screen includes an on-screen keyboard 130 and a text display area 210. As mentioned above, the on-screen keyboard 130 is optional because if the alphabets are printed around the joystick device, the on-screen keyboard component would be unnecessary.

The on-screen keyboard area can take a variety of shapes, including but not limited to circle, square, oval and polygon with any number of sides. The visual representation is typically, but not limited to, a two-dimensional plane figure.

The on-screen keyboard 130 may be enhanced by, or even replaced with, a set of compass point letters, which are 'A', 'H', 'N' and 'U'. Compass point letters can be placed in a separate compass area on screen as shown in FIG. 4A. They can also be placed around the word selection list as shown in FIG. 4B. These compass pointer letters can also be placed in an interactive pointer/cursor on screen or even around the joystick device 110.

The letters in the on-screen keyboard 130 can be arranged in any order or orientation. In the preferred layout as shown in FIG. 2, all letters have their bottoms towards the center of the ring. In an alternative layout, all letters may be upright. In the preferred layout as shown in FIG. 2, the letters are ordered alphabetically. In an alternative layout, the letters may follow the Dvorak order. In the preferred layout as shown in FIG. 2, the letters start at the 12 o'clock position. In an alternative layout,

the letters may start at the 9 o'clock location. Alternatively, the letters may have a moving starting position in a rotating keyboard in an embodiment, for example, where the input device is a type of wheel. In the preferred layout as shown in FIG. 2, the letters are placed clockwise in the character ring. In an alternate layout, the letters may be placed counterclockwise. In the preferred embodiment as shown in FIG. 2, letters occupy different amount of radians depending upon their frequency of use in the language, giving more frequent letters a larger target area.

Likewise, the digits can be arranged in any order or orientation. In the preferred embodiment as shown in FIG. 3, the digits would be located adjacent to the series of letters assigned to the corresponding digit keys on a telephone keypad.

The on-screen keyboard 130 may include letters of a primary input language, letters of alternate input languages (and/or accented letters), digits, and punctuation symbols. The keyboard may also include character components for pictographic languages, diacritics and other "zero-width" characters that attach to preceding characters. The keyboard may further include tone marks, bi-directional characters, functions indicated by a word or symbol, and symbolic representation of a set of characters such as "Smart Punctuation" as described below.

The preferred primary text input keyboard as shown in FIG. 3 includes unaccented letters which form an outer ring, digits which form an inner ring, and a symbol or an indicator between the letters "z" and "a", called "Smart Punctuation", which intuitively determines which punctuation is most appropriate based on the word context.

There may be auditory and/or visual feedback on each joystick movement or button press. For example, as soon as the joystick direction is registered, a solid or

gradient-fill pie wedge shape could appear on the keyboard, centered on the current direction of tilt. Further, the width of that pie wedge could narrow in proportion to the tilt of the joystick towards the perimeter. The pie wedge could remain momentarily after the joystick is returned to its center/resting position. The pie wedge provides a visual cue that the tilt of the joystick was registered and reinforces the notion that each action represents a range of possible letters. FIG. 5 depicts a visual feedback for a joystick movement. The solid pie wedge 502 on the keyboard 302 shows the current direction of the joystick and the range of letters in that direction.

Referring back to FIG. 2, the text display area 210 includes a word choice list region 224 and a message area 220. The word choice list is a list of words that the system predicts as likely candidates based on the characters entered by ambiguous directional input.

The most likely word is a default word. The user can either accept the default word with one action, or select an alternate word with a combination of actions.

The exact spelling sequence of exact characters coincidentally selected by the user is also displayed. Preferably, the spelling sequence is displayed in a separate area above or below the word choice list. Alternatively, it may be displayed as an entry in the word choice list, typically the first line or the last line. In FIG. 2, the exact spelling sequence 222 is displayed above the word choice list 224.

The last letter entered is also indicated both on the on-screen keyboard and in the exact spell sequence, by some method including but not limited to font change, color change, reverse video or alternate background color, underline, bold face or italics, and outline. Example of outline can be a box or a circle.

All the words on the word choice list, other than the exact spelling sequence at the time when the exact spelling sequence is displayed as the first or last entry, are ordered by a combination of the shortest calculated distances between the joystick entry sequence and each letter in each word and the recency of use and/or the frequency of use within the given language.

The directional input system 100 implements a method whereby the user can select a specific word from the word choice list. Preferably, the method is consistent with other applications use of scrolling methods and selection button. The system also includes a means of selecting the exact spelling sequence as well as any predicted words. In one preferred embodiment, the system may include a next button and a previous button, with which the user can navigate forward and backward through the word choice list.

Alternatively, the directional input system 100 may include a selection mode switch button. When the selection mode switch button is pressed, the system enters a selection mode and the directional input means can be used to scroll forward and backward through the word choice list.

In addition, selecting a predicted word using a particular means may replace the exact spelling sequence as if the letters of the selected word had been entered directly by the user, and a new list of predicted words is generated.

The most likely word is the word added if the user does not try to select a different word. The default word may be a copy of the exact spelling sequence if the user was accurate. Alternatively, it may be the selected word as described above. In addition, the exact spelling sequence may become the default word if a precision method or

mode (described below) is used to explicitly choose at least one letter in the sequence.

Words that are longer than the number of joystick actions registered in the current entry sequence may be included in the prediction list. Alternately, a further means
5 can be provided to extend a selected word with completions. For example, longer words that begin with a selected word may appear on a pop-up list after a button press or directional input, similar to the cascading menus on PC windowing systems.

Once a word is entered, the word is typically displayed in the message area 220.

Alternatively, the directional input system 100 can be implemented as an input
10 method editor (IME). In this case, the text entered by the system goes into whatever program is actively accepting input from the system. Other applications may be linked to the system, or the system may be incorporated as part of another application. These applications include but are not limited to: instant messaging, electronic mail, chat programs, web browsing, communication within a video game,
15 supplying text to a video game, as well as word processing.

To enter a text message using the directional input system 100, the user first points the joystick in the general direction of the desired letter, and then continues pointing roughly to each letter in the desired word. Once all letters have been roughly selected, buttons are used to select a specific word from the list of potential matches.
20 The selected word goes into the message area 220, which may be an appropriate text application such as email or instant message.

The invention also provides a method for precisely choosing the letters of a word. The method is useful for entering uncommon names and any word that is not part of the standard language currently active. The method can also be used to change the last character entered by stepping between characters adjacent to the last character entered. To step between characters adjacent to the last character entered, a forward button and a backward button may be used. Once the character entered has been changed, the word choice list refreshes to reflect the changes in the predicted words. Alternatively, the system may be switched to a precision mode and the directional input means may be used to cycle through letters. To switch to the precision mode, the system may choose to use the degree of joystick tilt from the center. Once the tilt exceeds a preconfigured limit, the system switches to the precision mode. Alternatively, the system may use the time interval that the joystick dwells at the perimeter. Once the time interval reaches a preconfigured limit, the system switches to the precision mode and notifies the user through a visual cue or a tone. The system may also include a button for switching to precision mode.

FIG. 6 is a flow diagram illustrating a process for operating the directional input system in the precision mode to select an exact letter. The process includes the following steps:

- Step 600: The user switches to precision mode. This is typically a clicking on a predefined button. However, any of the above mentioned method can be used.
- Step 602: The system can optionally zoom in on the area of the last character entered.

- Step 604: The user uses directional input to drive an indicator to the desired character. If the joystick is used for directional input and if the zoom-in has been employed, then the system processes joystick movement at a finer resolution. For example, a radial move of 90° is treated as if it were only 30°.
- 5 • Step 606: The user uses a button to accept the character.
- Step 608: The system optionally returns to normal directional text entry mode.

In addition to the preceding methods, the system may determine the precise letters by detecting the difference in speed of selection or change in acceleration, especially when the system embodiment is based on a directional selection means employing a
10 wheel.

In the preferred embodiment above, the directional input system 100 is deployed to a home video game console machine. However, this technology can also be deployed to many other products such as portable video game devices, phones with the appropriate input methods, wheelchairs, and TV related electronic devices, etc. In
15 TV related electronic devices, for example, the invention may be deployed as set-top boxes and the joystick/rocker may be incorporated in the remote controls.

FIG. 7 is a flow diagram illustrating a direction input method according to another preferred embodiment of the invention. The method includes the following steps:

- Step 700: The user moves an on-screen cursor in the direction of the desired
20 letter using a joystick, or any other directional input means.

- Step 702: The system records the X-Y coordinate position of the cursor.
- Step 704: The system converts recorded X-Y coordinate position into corresponding set of polar coordinates.
- Step 706: The system applies a selection weight value to each input based on the set of polar coordinates of the recorded cursor position.
- Step 708: The system retrieves a list of predicted words based on the weight values for each of input and a set of pre-determined values.

For internal calculations, the on-screen keyboard 130 may be represented internally in the same way as the screen using direct mapping. Alternatively, it can be represented in a very different format using virtual mapping. The internal representation of keyboards may use any coordinate system, including but not limited to Polar and Cartesian coordinate systems.

When the on-screen keyboard 130 is represented internally using a Polar system, key positions are set by bounding angles and radial distance from the center. In the preferred embodiment, multiple concentric circles are permitted. The system can accept direct Polar inputs. Alternatively, it can map Cartesian inputs into Polar coordinates before performing calculations.

When the on-screen keyboard 130 is represented internally using a Cartesian system, key positions are set by left, right, top, and bottom of a bounding box. The horizontal and vertical positions are relative to one corner, usually top left but can

vary by platform and operating system (OS). In the preferred embodiment, multiple rows of keys are permitted.

The directional input system 100 may also alternate between several keyboards for a variety of reasons. Such reasons may include the following: uppercase vs. lowercase letters, alphabets for other supported languages, extended alphabets for languages with large numbers of letters, diacritics, numbers vs. letters, symbols and punctuation, strokes vs. character components, different alphabets for the same language, function keys, and precision mode for selecting specific exact spell characters.

10 In another preferred embodiment of the invention, the directional input system 100 also provides a mechanism for changing the keyboard face and the input directions. The system includes an input means to switch among a set of system modes. A mode is a combination of keyboard, key-map, and sometimes dictionary. Modes can be used for many things, including but not limited to entering characters, executing
15 functions, and changing system parameters.

In the preferred embodiment, the system may also contain the following buttons: Space or Select word, Backspace, Next & Previous word, Next & Previous character, Shift/Caps Lock, and Menu/Mode switch. Each of these buttons is mapped to a system function. The functions that can be performed by buttons include, but are not
20 limited to the following:

- *Select*: Adding a specified word to the message area and at the same time clearing out the current word;

- *Next/Previous word*: Altering which word is highlighted for selection;
 - *Next/Previous character*: Altering the last character entered;
 - *Backspace/Delete word*: Deleting a character or word;
 - *Shift, Caps lock*: Altering the case of letters being entered;
- 5
- *Undo*: Undoing last function or entry;
 - *Cut/Copy/Paste*: Standard clipboard commands;
 - *Escape*: Activate/deactivate the directional text input;
 - *Toggling Next Lock/Hold*;
 - *Extend or Add Suffix*: Selecting a word and displaying its possible suffixes or
- 10
- using any additional characters entered to extend the selected root word;
 - *Change to a new Language*;
 - *Change to a new Keyboard layout*;
 - *Download/install new language/keyboard layout/program version*; and
 - *Toggle Precision mode for Exact Spell*.

Some characters that can optionally be entered by buttons include, but are not limited to:

- “*Smart Punctuation*”, which intuitively determines which punctuation is most appropriate based on the word context;
 - 5 • “*Smart Diacritics*”, which intuitively determines which diacritic to be added; and
 - “*Smart Tones*”, which intuitively determines which tone to be added to a word for tonal languages, such as Vietnamese. Alternately, a tone key could display a selection of tones to add to the current word or last character entered.
- 10 The directional input system 100 supports multiple languages. Each language supported is stored in a separate language database (LDB). The language database stores words organized by word length and frequency of use within the given language. When the system uses case sensitive letters, the database storage is also case sensitive and thus words are stored in a mixed case format.
- 15 The directional input system 100 can optionally support user added words. These words are either stored in a separate user database (UDB) or appended to the primary language database (LDB). When a UDB is used, it organizes words by word length and recency of use.

The directional input system 100 can optionally support dynamic word prediction, where likelihood changes are made either by re-ordering sections of the LDB, or via
20 a recency database (RDB) which is organized by word length and recency of use.

The final word choice list is retrieved and ordered using the following types of data: word length, ordinal ranking, letter weight, and recently used words. Only words that have at least as many letters as the letters entered are presented. When "Word Completion" is used, longer words may be presented if they are determined to be likely. Words in the LDB may be ordered by frequency, most common first, and least common last.

The invention adopts an algorithm which matches the entry sequence to letters of words in the LDB based on their nearness to the point/angle of each entry. For example, the weighting may approximate an inverse square of the distance from the center of the corresponding letter. Grouping letters for efficiency is an optional, yet preferred feature; it excludes letter matching when the letter is far outside of the smaller area of adjacent letters surrounding the point/angle of entry. A detailed description of the algorithm is set further in the copending application, U.S. Serial No. 09/580,319, filed on May 26, 2000, entitled "KEYBOARD SYSTEM WITH AUTOMATIC CORRECTION". This detailed description is hereby incorporated by reference.

Each letter in a keyboard group has a relative weight to nearby letters. When one letter is entered, nearby letters are taken into account, and all of these letters are assigned a likelihood weight. The actual letter entered has the highest weight, and the weight decreases with distance from the exact letter. These letter weights combine to alter the order of likely words presented in the word choice list.

Recently used words may be weighted as more frequent, so their likelihood is increased and they are shown higher in the word choice list. Recency information is

also used for determining the placement of user-defined words in the word choice list.

5 The directional input system 100 also supports word completion. If the system suspects that the letters entered are the beginning part of a longer word, longer words that roughly match are presented in the word choice list. Alternatively, the system can present the user a list of suffixes for a stem word. If a root word is selected with a "suffix button", a list of suffixes is then displayed at the end of the root, allowing the user to select the suffix of choice.

10 The directional input system 100 also allows the user to select a partial word while still building a word. The list is then filtered to only include words that begin with the chosen word stem. If a user scrolls down to an alternate word, and then adds more letters, this alternate word continues to be the selection, highlighted by the method discussed above, until it becomes invalid by further addition of characters.

15 Although the invention is described herein with reference to the preferred embodiment, one skilled in the art will readily appreciate that other applications may be substituted for those set forth herein without departing from the spirit and scope of the present invention.

Accordingly, the invention should only be limited by the Claims included below.